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ABSTRACT

Age and instructional differences in the representation of pictorial information were investigated in a recognition memory task. A total of 56 nursery school and 40 college-age subjects observed pictures under name labeling, color labeling, imaging, and no label instructions. Subjects were then tested for retention of object identity and color information. In general, no label instructions led to poorer performance than any other condition; the three remaining groups, given an instruction requiring a discriminative response to each picture as it was shown, performed equally well. Significant age differences were found in memory for both object identity and color information; however, nursery school and college-age subjects showed similar relative performance when tested for these two kinds of information, and most subjects at each age level showed superior retention of object identity over color information. These results suggest some limitation on the generality of claims that young children are more oriented to color information than are adults and, more importantly, that children represent their experience ikonically while adults tend to use a symbolic mode of representation. (Author/SET)

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THE ENCODING OF PICTORIAL INFORMATION IN CHILDREN AND ADULTS

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Abstract

Age and instructional differences in the representation of pictorial information were investigated in a recognition memory task. Nursery school and college-age subjects observed pictures under name labeling, color labeling, imaging, and no label instructions. Subjects were then tested for retention of object identity and color information.

In general, no label instructions led to poorer performance than any other condition; the three remaining groups, given an instruction requiring a discriminative response to each picture as it was shown, performed equally well. Significant age differences were found in memory for both object identity and color information; however, nursery school and college-age subjects showed similar relative performance when tested for these two kinds of information, and most subjects at each age level showed superior retention of object identity over color information. These results suggest some limitation on the generality of claims that young children are more oriented to color information than are adults and, more importantly, that children represent their experience ikonically while adults tend to use a symbolic mode of representation.

The Encoding of Pictorial Information in Children and Adults

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Do people have available to them different modes of representing the world? Bruner, Olver and Greenfield et al. (1966) have proposed three modes by which a person can "know something." An experience can be known through actions, or enactive representation; through imagery or mental pictures, called ikonic representation; or through symbolic representation which requires the mapping of experience onto a system such as language. Enactive representation is proposed to appear first (0-2 years), and to be the only mode of representation available to the infant. Ikonic representation then develops and becomes dominant up to age 7 to 9, although enactive representation certainly occurs in some situations (for example, learning to ride a bicycle). Finally, all three modes of representation are available in older children, although the use of the symbolic mode, in the form of language, accounts for developmental change and improvement in a variety of cognitive tasks.

The description of representational modes actually involves two distinct, although interacting, questions: At any given age (or more generally, developmental level) does a person have a particular mode of representation available to him; and, given that a particular mode of representation is in a person's repertoire, under what conditions does he use it? Thus, in addition to age the demands of the task--stimulus material, type of test, and so on--may be important in determining the mode of representation used. In fact, development may be considered to involve both an expansion of the repertoire of representational modes and the enhancement of the ability to determine the most efficient mode of representation for any given task. There is

experimental evidence that, contrary to the usual assumption, the symbolic mode is not optimal for all experimental tasks. Ranken (1963) showed that visual imagery may be superior to verbal coding in recall of novel shapes. Similarly, ikonic representation may be advantageous in Corsini, Pick, and Flavell's (1968) model building task or in Daehler, Horowitz, Wynns, and Flavell's (1969) task requiring the use of positional information. Distinguishing between the availability of a particular representational mode and the ability to use it selectively switches emphasis from inferring mode of representation solely as a function of age to the search for task differences and age by task interactions.

The present experiment was designed to investigate differences in representation among subjects required to remember pictured information. The task was one developed by Shepard (1967); subjects view a large number of pictures, one at a time, and then are tested with pairs of pictures. Adults, after viewing up to 2500 pictures, have typically been able to choose the "old" member of the pair with about 95% accuracy (Standing, Conezio, & Haber, 1970).

The stimuli were chosen so as to leave the subject maximum freedom to encode either ikonically or symbolically. They were all pictures of single, common objects which we expected would be easily recognized even by young children, and for which a simple, familiar label would be appropriate. Half were appropriately colored, and half were achromatic.

Both nursery school children and adults served as subjects. Following Bruner et al. (1966), preschool-age children should spontaneously encode ikonically, while adults would tend to use symbolic (verbal) representation. In addition, four instructional conditions were employed to allow discovery of whether instructions could induce subjects within an age level to use different

encoding strategies. The four instructions used were Name Labeling, Color Labeling, Imaging, and No Labeling. Name Labeling was thought to provide the strongest encouragement for the use of a symbolic representation, while Image instructions were seen as encouraging ikonic representation. Color Labeling might have encouraged either representational mode. The main purpose of the Color Labeling, however, was to serve as a control condition possessing, beyond the No Label condition, the requirement that the subject must make a discriminative response to each picture shown, assuring attention to the stimuli.

Mode of representation cannot be observed directly, but must be inferred from age and instructional differences in performance. Assuming that subjects will perform better when instructions are most consonant with their spontaneous mode of encoding, nursery school children may be predicted to show better performance in the Imaging than in the Name Labeling condition, while adults might show the opposite pattern.

These predictions are made for performance on the Standard test, on which, as in Shepard (1967), subjects were forced to choose the "old" object from two pictures of different objects; thus, the availability of object identity (or form) information was tested. In addition, a Chromaticity test was given in which two versions of the same picture were presented, differing only in that one was in color and the other was achromatic. Here the subject had to indicate which version of the picture he had earlier been shown. It was argued that subjects who encoded ikonically would be more likely than those who encoded by the use of a verbal label to have color information available. Thus age or instructional differences associated with differences in the availability of this ikonic information would, by inference, indicate differences in the use of an ikonic representation.

Two dependent measures were used for both the Standard and the Chromaticity tests: an error measure, as previously used in this task, and a measure of response latency. Given an expected nearly errorless performance by adults, at least on the Standard test, latencies might provide a more sensitive index of instructional effects on memory for them. Since it is difficult to obtain sensitive latency measures with young children, on the other hand, errors might prove the better measure for this group.

This experiment, then, investigates differences in mode of representation of information in a recognition memory task as a function of age and instructions. Subjects were encouraged to use a particular mode of representation and were tested for their retention of both object identity information and a specific type of visual information. Differences in encoding are to be inferred from age and instructional differences in latency and error measures of performance on the two types of memory tests.

Method

Design. The experiment consisted of two parts: Presentation and recognition test. In the presentation the subject was shown a series of pictures to be remembered. Subjects were randomly assigned to one of four instructional conditions for the presentation. For each subject the test consisted of both "Standard" and "Chromaticity" recognition tests, with half of the subjects in each instruction condition receiving the standard test before the chromaticity test. Each of the eight cells of the design contained three boys and four girls for the four-year-olds, and two males and three females for the adults. These disproportions approximated the discrepancies in volunteer rate for the different categories of subjects.

Stimuli. Stimuli were drawn from a commercially prepared set of about 400 drawings. Those employed in test trials were the 96 pictures of single objects or animals which it was judged would be most familiar to and easily labeled by four-year-olds. Thirty additional pictures from the set were used in practice trials. Two versions of the stimuli were available. The achromatic version consisted of black outline drawings on a white background, while the chromatic set was identical except that the interior of the figure was colored appropriately. Stimuli were randomly chosen from the 96 to serve as "target" stimuli in the recognition memory tests (32 each) and as distractors in one of these tests (32); half in each test were randomly chosen to be presented in their chromatic version and half in their achromatic version.

Equipment. A Kodak carousel projector was used to back-project pictures onto a small translucent screen (22 x 26 cm.) mounted in a dark green frame. During presentation one picture at a time was shown. The pictures were centered on the screen at eye level, and occupied an area of about 35 square cm. During the recognition tests two pictures of the same size were presented simultaneously. The subject was seated immediately in front of the screen, so that he could press the screen to indicate his choice of pictures and to advance the projector. The experimenter sat at a table behind and to the side of the subject, so that she could observe his choice of pictures. A Hunter Klockounter 220 was used to time latencies to the nearest millisecond during the recognition tests. The timer was activated by a photocell on the rear of the screen and was stopped by a microswitch which operated when the screen was pushed.

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Procedure. For the initial presentation of pictures each subject was told that he would be shown a large number of pictures on the screen; that he

could look at each picture as long as he wanted, and then push the screen to see the next picture, and that his memory for the pictures would be tested after all the pictures had been shown. No information was given as to the nature of the test. There were four instructional conditions. In the No Label group, the subject had only to look at each picture and then press the screen. Subjects in the Name Label group were required to give the name of the object before pressing the screen. Those in the Color Label group named the (predominant) color of the picture. Finally, those in the Image group were told to close their eyes and picture the object in their heads. Subjects were given 10 practice trials with whichever procedure they were to follow before beginning the main series of pictures; corrections and repetitions of instructions were made as necessary during these trials.

Seventy-four pictures were shown to each subject. The first 64 were, in random order, the "target" stimuli in the 32 item standard test and the 32 item chromaticity test. The last 10, along with the 10 practice pictures shown before the main series of pictures, provided items for use in practice trials illustrating the recognition test procedure.

In the recognition test, two pictures were shown side by side. One picture was always presented just as it had been in the initial presentation; the other was always a distractor. In the Standard test, the distractor was a picture of a different object, but of the same chromaticity as the target--i.e., in color if the target was in color, otherwise in black and white. In the Chromaticity test, the distractor was a picture of the same object, identical to the first except that it was of changed chromaticity.

During the recognition test, pacing was controlled by the experimenter. When the subject pressed the screen to indicate which picture he had seen

during presentation, a blank slide appeared. The experimenter recorded choice and latency, and then pressed a button to present the next test slide to the subject. This procedure, along with the nature of the test, was explained and practiced with three slides. The subject was then told that he should make his choice as fast as possible, and was given seven more practice slides. After the first test was completed, the same procedure, including 10 new practice slides, was repeated for the second type of recognition test.

Subjects. Subjects were paid volunteers, recruited through newspaper ads from a predominantly upper middle class community. Among the children, the 24 boys and 32 girls ranged in age from 43 to 61 months (mean = 53.3); while the adults, 16 males and 24 females, ranged from 18 to 26 years (mean = 21.6). Eighty-five percent of the adults had completed at least one year of college; 80% of the children had had nursery school experience.

Results

Preliminary comments. Subjects were generally alert and attentive during both the initial stimulus presentations and the test trials, and mastered the screen-pushing requirements of the task without difficulty. So far as could be judged, subjects were able to respond during the initial presentation as their instructional conditions required. Labels given by children in the Name Label group were examined to determine whether the pictures used were indeed familiar and nameable for four-year-olds; the total number of inappropriate, nondistinctive, and missing labels ranged from 0 to 11 for individuals, averaging 4.8. In the Color Label group, it was difficult to judge how many inappropriate labels were given since pictures frequently were multicolored and since children often used distinctive labels not in agreement with adult usage;

for example consistently labeling yellow pictures "brown." Two subjects failed to show discrimination in their color labels. It was decided, however, not to exclude any subjects in either labeling group in order not to bias these groups toward older or brighter subjects than those in the two remaining groups. Self-reports by the adults, and parental reports for the children, indicated that none of the subjects were color-blind.

There is no direct evidence as to what subjects in the Image group did during the stimulus presentations. All that can be said is that both children and adults behaved as though the instruction to image was a meaningful and reasonable request. Also, in pilot work, four-year-olds asked, for example, to image a dog responded with confidence when asked for details as to its color, stance, kind and so on.

The data were examined for evidence of position and other biases in the subject's responses. Seven children showed extreme biases, mainly in always choosing the chromatic picture in the chromaticity test; these subjects were replaced. Latencies were discarded for any trial on which the subject made an error, and also for trials on which the experimenter noted that the subject was inattentive.

There were no differences in age among the four instructional conditions for either children or adults; nor did the adult groups differ in level of education. Age and education also failed to relate to level of performance in the recognition tasks, except that, among the children, there was suggestive evidence that older subjects performed better than younger ones under Image instructions: The rank order correlation rho between age and number correct was .56 ($p < .05$) on the Standard test and .52 ($p < .07$) on the Chromaticity test.

Number correct. Data were analyzed separately for each age group for each type of recognition test. A three-way analysis of variance was employed, with instructional condition and test order as between-subjects factors, and stimulus type (pictures presented originally in black and white vs. those presented originally in color) as a within-subjects variable. Means and standard deviations for the four instructional conditions are presented in Table 1. When children were shown pictures of two different objects and asked

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Insert Table 1 about here
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to point to the one previously shown (Standard test), a significant effect of conditions was found ($p < .01$): Those in the No Label group remembered fewer pictures than those in any other condition (by Student-Newman-Keuls test, $p < .05$ for Color Label; $p < .01$ for Verbal Label and Image). Adults, on the other hand, showed nearly perfect performance, and no condition differences.

When subjects were shown a previously displayed picture and required to indicate whether or not the picture had been displayed in color (Chromaticity test) neither age group showed significant condition differences. It may be of interest to note, however, that for both children and adults, the group engaged in color labeling during the initial presentation of pictures remembered the most information about color (by a post hoc U-test, comparing Color Label Ss with all others, $p < .05$ for children and adults).

Order of testing had no effect in these analyses, nor, in separate condition by order by sex analyses, were there any effects associated with sex. There was however a significant effect of stimulus type in the child data; subjects were more often correct in remembering both the identity ($p < .01$) and the chromaticity ($p < .001$) of pictures that were originally presented in

color. No difference appeared in the data for adults. The mean number correct on each stimulus type for each age group is presented in the first two columns of Table 2.

Insert Table 2 about here

Latencies. Response latencies were obtained as a second measure of performance on the assumption that adults' latencies might be sensitive to treatment effects which their accuracy scores, because of ceiling effects, would not show. The subject's median latency for correct responses was used. Means of these medians for each instructional condition are presented in Table 3. On both tests and for both age groups, subjects in the No Label

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Insert Table 3 about here

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group responded more slowly than those in any of the other groups; the differences among conditions reached significance only for the adults ($p < .01$ for Standard test; $p < .05$ for Chromaticity test). Post hoc U-tests were run comparing latencies in the No Label group with those of subjects in all other groups combined. There was a significant difference on both tests for adults ($p < .05$), but on neither test for children.

Mean latencies for colored and for black and white pictures are shown in the last two columns of Table 2. All four analyses showed a significant effect due to stimulus type: Subjects were faster in recognizing both the identity and the chromaticity of pictures that had been presented in color than of those that had been presented in black and white. Nonparametric analyses confirmed the reliability of this finding; for the various groups and tests, the percentage

of subjects whose median latencies were shorter on stimuli originally presented in color ranged from 75% to 85% (by sign test, $z \geq 3.37$, $p < .001$).

Comparisons across tests and age groups. Adults made fewer errors and had shorter latencies than children on both recognition tests ($t \geq 4.02$, $p < .001$). Of greater interest, however, is the comparison of relative performance by the two age groups on the two types of test. One approach is to determine what percentage of the subjects of each age level had better performance on each type of test. Ninety-eight percent of the adults and 84% of the children made fewer errors on the Standard than on the Chromaticity test; while 73% of the adults and 58% of the children had shorter median latencies on the former. All but the last of these percentages represent a significant departure from chance level, indicating a general tendency toward better performance on the Standard test. However, for neither score did the two age levels differ significantly ($z \leq 1.63$; $p > .10$).

It is also interesting to examine proportional differences in number correct between the two tests. Using mean performance over all groups as the basis for comparison (there were no significant group differences), both children and adults made 82% as many correct choices on the Chromaticity test as on the Standard test; when the scores are corrected for guessing, these percentages become 56 and 62, respectively. Thus, there is no evidence in these data that children are superior in their memory for ikonic information, either in comparison to their own memory for object identity or relative to performance by adults.

Item analyses. Errors were examined to determine whether children and adults found the same items to be relatively more difficult; agreement would provide further evidence of similarity in how stimulus information was encoded and used in the task. In number of errors on the Standard test, where there

was a severe restriction of range for the adults, nonsignificant positive correlations were obtained between the two age groups--.43 for chromatic pictures, .14 for achromatic, and .32 ($p < .08$) for the two types combined. For the Chromaticity test, where there was not such restriction, the correlations were high and significant--.72 for chromatic pictures, .69 for achromatic, and .61 over the two types ($p < .01$ for each correlation).

Discussion

These data have relevance to two issues tangential to the major purpose of the study. The first is the effect of verbal labeling upon children's memory. With elementary school children, overt labeling generally has a facilitative effect (Hagen & Kingsley, 1968). In preschool children this effect has sometimes been found (Ward & Legant, 1971) and sometimes not (Kingsley & Hagen, 1969). The present results give further evidence for a facilitating effect in preschool children but, along with Bush and Cohen (1970), indicate that it may not be specific to distinctive verbal labels. Here, all instructional conditions which required responses contingent on characteristics of the stimulus, even the covert responses required in imaging, were equally helpful. A parsimonious interpretation of this literature would be that--outside of special cases, such as an increase in the probability that an item is maintained in primary memory--labeling has an influence in young children only through assuring attention to the stimuli. It appears also that it is not a sufficient control for attention to watch, as did Ward and Legant (1971), to see that the child orients to the stimulus and to time presentation from that point; i.e., central, not just peripheral, attention is affected by labeling.

Second, the claim has frequently been made that children around three or four years of age are more oriented to color information than are older children or adults. Studies of dimension preferences in perceptual matching tasks have generally supported this position (e.g., Corah, 1966). However, several studies, including the present one, have failed to find any relative or absolute preference for color when children must store information or use it in more complex problem solving (e.g., Gallagher, 1971; Hale & Morgan, in press). The possibility is raised that color preference in young children is a phenomenon limited to tasks requiring minimal cognitive processing of the information.

As for the major focus of the study, the effects of age and instructions on the representation of information, it remains logically possible that subjects could have stored similar information in different ways; they might, for example, have verbalized names of colors as well as names of objects in the labeling conditions. The general lack of condition effects on latencies increases the implausibility of this proposition: Certainly, different modes of representation, if they do not lead to differences in what is stored, ought at least to lead to differences in the ease of access, and therefore the latency, for information of a given kind. It seems more likely that our subjects knew better than we how they could best remember the information they were given, and proceeded to use their preferred encoding strategy regardless of instructions. Paivio has suggested a similar tendency in adults instructed as to the type of mediator to be used in relating pairs of nouns (Paivio, 1971, p. 362).

Following this argument, the lack of age differences in what is remembered indicates that children and adults are similar in the approach they find to be efficient. Moreover, it is likely that this approach involved ikonic rather

than symbolic (verbal) encoding--in view of the young child's disinclination for verbal mediation (e.g., Kendler, 1963), it is more reasonable to hypothesize that all subjects tended to store images which would contain color as incidental information, than that they recoded both object identity and color information into verbal terms.

It remains to be seen whether the ikons of children and adults are equivalent in all respects. The present study shows them to be similar in one aspect, the degree to which they contain information as to the presence or absence of coloring in a picture. Other variables, such as orientation, can be examined in a design similar to the present one. It is possible that we will find age changes not in the mode of representation used, but in the stimulus characteristics which an ikon is most likely to preserve.

If adults use ikonic storage with materials that can easily be encoded in either of two ways, in what circumstances will they prefer to encode symbolically? Perhaps only when we give them little alternative--by the use of materials poor in image value, of speeded conditions which give too little time for the development of images, or the expectation of testing procedures which require that the response be translated into verbal terms. Child-adult differences may then be found, not in situations where the subject has an open choice as to his approach, but in the degree to which he can adapt effectively to constraints imposed upon his performance.

Nothing in the foregoing discussion touches upon the consistent differences found in latencies, and for children in number correct, between chromatic and achromatic pictures. A bias toward picking the colored member of the pair could explain the effect in the Chromaticity test, but not in the Standard test, in which the distractor was always of the same chromaticity as the target stimulus.

One possibility is that subjects were more attentive to the colored pictures during their initial presentation. Another is that, at the time of test, pictures were identified more rapidly when they were in color, and that such identification preceded the search through memory to discover whether the picture was a familiar one. Work is now under way to determine, at least, whether the difference between chromatic and achromatic pictures arises during their initial presentation and storage, or whether it takes place during the retrieval of information at the time of test.

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Table 1

Mean Number of Correct Choices

		Condition				
		No Label	Color Label	Name Label	Image	All Groups
Standard Test						
Children	M	23.14	26.86	28.64	28.64	26.82
	SD	5.76	4.38	4.40	3.39	4.98
Adults	M	31.30	30.40	31.40	31.30	31.10
	SD	1.06	1.43	0.97	1.64	1.32
Chromaticity Test						
Children	M	20.50	23.89	22.25	21.68	22.08
	SD	4.80	4.76	4.01	3.91	4.45
Adults	M	24.20	27.20	24.00	26.20	25.40
	SD	4.10	2.20	2.62	2.90	3.22

Table 2

Mean Number Correct and Mean Latencies for Pictures Presented Chromatically and Achromatically

		Number Correct		Latencies	
		Chromatic	Achromatic	Chromatic	Achromatic
Standard Test					
Children	M	13.84	12.98	2427	2605
	SD	2.16	3.15	538	582
Adults	M	15.60	15.50	1199	1271
	SD	0.71	1.01	284	291
Chromaticity Test					
Children	M	12.34	9.74	2468	2836
	SD	3.30	3.55	678	809
Adults	M	12.98	12.43	1401	1645
	SD	2.27	2.18	609	909

Note.--Latency entries are means in milliseconds of individuals' median latencies to correct choices.

Table 3

Means of Latencies to Correct Choices

		Condition				
		No Label	Color Label	Name Label	Image	All Groups
Standard Test						
Children	M	2662	2538	2333	2531	2516
	SD	648	479	538	445	532
Adults	M	1451	1206	1106	1176	1235
	SD	394	144	217	200	279
Chromaticity Test						
Children	M	2918	2433	2538	2719	2652
	SD	890	514	649	681	701
Adults	M	2142	1336	1247	1368	1523
	SD	1260	316	188	353	748

Note.--Entries are means in milliseconds of individuals' median latencies to correct choices.